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Control device and method for actuating a means for protecting vehicle occupants and/or road users

The invention relates to a control device for actuating a means for protecting vehicle occupants and/or road users for a motor vehicle according to the preamble of claim 1, and to a method for actuating a means for protecting vehicle occupants and/or road users for a motor vehicle according to the preamble of claim 8.

DE 100 29 061 A1 has disclosed a vehicle occupant protection system having an electromotive seatbelt pretensioner for pretensioning a seatbelt, and having a control device for actuating the seatbelt pretensioner. The control device determines whether a potential accident situation is occurring by means of dynamic translational movement parameters such as travel speed, yaw angle, yaw acceleration, lateral acceleration and longitudinal acceleration and manipulated variables such as pedal travel, pedal force or steering angle. If a potential accident situation is determined, the electromotive seatbelt pretensioner is actuated and triggered.

In such a vehicle occupant protection system it is possible for undesired triggering processes of means for protecting vehicle occupants to occur, i.e. for example for the seatbelt to be pretensioned without the travel situation requiring this, and in particular without this appearing appropriate to the driver or to other vehicle occupants.

A comparable problem occurs with road-user protection means which can be actuated, for example an engine hood which can be raised preventively, extendable pedestrian impact elements or surface elements of the vehicle

whose hardness can be adjusted.

WO 01/79036 A1, which forms a generic type, discloses an arrangement for largely reducing undesired triggering processes of a restraint device in a motor vehicle. A rollover decision is taken by this arrangement on the basis of a rotational speed which is sensed in the vehicle. This rollover decision is used to trigger a restraint means. In order to avoid undesired triggering of the restraint means, the arrangement additionally comprises a plausibility checking device which uses acceleration values which are sensed in the vehicle to carry out plausibility checking of the rollover decision, i.e. determines whether the rollover decision is plausible. Only a rollover decision which is detected as plausible gives rise to triggering of the restraint device. Plausibility checking is carried out, for example, by a combined threshold value interrogation for the longitudinal acceleration and the lateral acceleration.

Taking WO 01/79036 A1 as the closest prior art, the object of the invention is to permit improved plausibility checking of a triggering decision for means for protecting vehicle occupants and/or road users, as a result of which the number of undesired triggering processes can be reduced.

This object is achieved by means of a control device for preventively actuating a means for protecting vehicle occupants and/or road users having the features of patent claim 1, and by means of a method for actuating a means for protecting vehicle occupants and/or road users having the features of patent claim 8.

The solution according to the invention prevents an undesired and/or an unnecessary triggering process of a means for protecting vehicle occupants and/or road

users, or at least reduces the probability of such a process. In particular the driver, and also other vehicle occupants or pedestrians, are not irritated or unnecessarily disrupted.

In addition, deployment of a reversible protection means, for example of a reversible seatbelt pretensioner, can be reduced by avoiding unnecessary triggering processes. As a result, the service life of protection means which can be actuated and which have a limited number (for example 500) of guaranteed triggering cycles is lengthened and/or smaller and more favorable restraint systems with a smaller number of guaranteed triggering cycles can be used.

In particular an output signal of a dynamic translational movement control system and/or an output signal of a brake assistance system are used as input signal of the decision stage. For example, a triggering decision is taken if a predefinable signal of a dynamic translational movement control system and/or a brake assistance system is sensed. The predefinable signal is, in particular, an activation signal, i.e. a signal which is output in order to intervene in the translational dynamics when the dynamic translational movement control system and/or the brake assistance system are activated. This has the advantage that a prompt triggering decision is made possible.

An essential factor for the plausibility checking of the triggering decision according to the invention is the detection of a travel behavior of the vehicle which is brought about by the driver in a deliberate and controlled fashion, and in this context in particular the differentiation between a travel behavior which is deliberately brought about by the driver and a travel behavior which is due to reflex actions and rapid reactions and/or a travel behavior which is not actively brought about by the driver.

It is particularly advantageous if the plausibility checking of a triggering decision is evaluated quickly by the plausibility checking stage. In order to permit very rapid plausibility checking, in one advantageous embodiment of the invention a desired travel behavior is determined in parallel with, or at least virtually simultaneously with, the triggering decision by considering a limited preceding time period of, for example, 5 s or 1 min, i.e. using parameters which are sensed in this time period or which describe this time period. As a result, reliable plausibility checking can be carried out on a triggering decision in real time, i.e. without a significant delay.

In particular controlled and manipulated variables which are predefined by the driver, for example the steering angle and position of pedals and in particular the change in the controlled and manipulated variables over time, as well as system settings which are predefined by the driver, for example the status or the switching on and switching off of a traction controller or of a dynamic translational movement control system, are used for checking the plausibility of the triggering decision and in particular for checking whether the travel behavior which is critical for safety is a desired travel behavior in the sense of a travel behavior of the vehicle which is brought about by the driver in a deliberate and controlled fashion. Parameters relating to a driver and to a stretch of road, such as the driving style or customary route selection, can also be used to determine the desired travel behavior. Further parameters which are sensed in the vehicle and which can advantageously be used to determine the desired travel behavior are dynamic translational movement parameters.

In particular a desired travel behavior can be inferred from the time profile, for example from the amplitude,

the frequency or the speed of a change in the dynamic translational movement parameters over time, as parameters which are indicative of the travel behavior.

In one advantageous refinement of the control device, the plausibility checking stage uses the change over time of a parameter which characterizes the translational movement dynamics in order to check the plausibility of a triggering decision. The plausibility checking stage evaluates a triggering decision as implausible if the change over time of the parameter which characterizes the translational movement dynamics drops below a predefinable threshold for the speed of change, i.e. changes only very slowly. For example, in the case of a slow yaw rate, i.e. one which does not increase suddenly but rather over a relatively long time period of, for example, several seconds, a triggering decision which is taken on the basis of a sensed yaw rate value which is above a threshold value is rejected as implausible since a travel state which is brought about by the driver in a deliberate and controlled fashion is inferred. Such travel states occur, for example, during test circuit runs or on helical multistorey carpark entry ramps in which the travel speed is slowly increased with an unchanged curve radius.

This example can be transferred to all other parameters, for example the attitude angle or the braking torque, which indicate a travel state which is critical for safety. Test situations and presentation situations are also detected from the profile of the sensed parameters and triggering of a protection means is prevented.

On the other hand, uncontrolled changes in travel states, for example changes in travel states which surprise the driver, still cause the means for protecting vehicle occupants to be triggered.

In another advantageous refinement of the invention, a travel behavior which is brought about by the driver in a deliberate and controlled fashion is inferred if a comparable travel situation occurs with a predefinable frequency within a predefinable time interval. If, for example, an emergency braking operation takes place for the third time within a time interval of two minutes, with the initial speed at the start of braking being between 60 and 80 km/h in each case, a travel behavior which is brought about in a deliberate and controlled fashion is inferred. In the example described it may be assumed that a test situation or presentation situation is occurring.

Likewise, understeering or oversteering and other travel states which are critical for safety and which have different initial speed ranges may cause a triggering decision to be evaluated as implausible. An essential factor with this refinement is that a predefinable number of repetitions (at least one) of a travel situation which is critical for safety takes place within a predefinable time period. Above the predefinable number of repetitions the plausibility checking stage then prevents this travel situation from serving as a basis for the triggering of the means for protecting vehicle occupants.

In this context use is made of the fact that after actual situations which are critical for safety the traffic situation and the driving style are such that an identical situation which is critical for safety does not occur again within a short time period of, for example, 20 s or 2 min, in particular that a similar or a largely identical situation is not repeated within such a time period. In particular, this applies to a multiple repetition within a short time period.

In order to increase the reliability of plausibility

checking, further criteria can be additionally checked by the control device according to the invention. For example, in the case of an emergency braking situation which occurs repeatedly within a few minutes it is possible to check additionally whether the steering angle or the yaw rate have an identical or at least similar value in each emergency braking situation. A travel situation which is brought about in a deliberate and controlled fashion is inferred, and the triggering decision which occurs on the basis of the emergency braking situation is evaluated as implausible, only if this condition is fulfilled.

In a further refinement of the control device according to the invention, exceptional travel situations are additionally predefined, with a triggering decision being filtered out as implausible, and the triggering of a means for protecting vehicle occupants being prevented, only when one of the predefined exceptional travel situations occurs. These exceptional travel situations restrict the range of the travel situations which do not lead to triggering of a means for protecting vehicle occupants to a predefinable set of selected situations so that a triggering decision can be evaluated as implausible with a particularly high degree of reliability.

The occurrence of an exceptional travel situation is detected by the control device from, for example, a predefinable dynamic translational movement pattern which is characteristic of this exceptional travel situation. A predefinable dynamic translational movement pattern means that a value range is defined for a set of dynamic translational movement parameters and the values of different dynamic translational movement parameters have a specified relationship to one another, that is to say the value ranges have a predefinable relationship.

As an alternative to or in addition to this, exceptional travel situations can also be characterized by manipulated variables such as steering angle and position of the accelerator pedal.

Furthermore, in order to characterize and detect exceptional travel situations by means of the plausibility checking stage it is additionally possible to use ambient parameters such as for example the external temperature, the road conditions, the coefficient of friction between the tire and underlying surface, the position of the vehicle which is sensed by means of a position sensing system, the distance from a vehicle traveling in front or from objects in the surroundings of the vehicle, the type of road (freeway, village road, residential road, carpark).

These parameters can of course also be advantageously used for determining according to the invention whether the travel behavior which is critical for safety corresponds to a desired travel behavior.

Exceptional travel situations can be characterized in particular by a predefinable statistical relationship and/or by a predefinable dynamic relationship of value ranges. It is additionally possible to characterize and detect an exceptional travel situation by reference to the dynamic profile of a single dynamic translational movement parameter. Exceptional travel situations which can be predefined and detected by means of characteristic parameters are, for example, traveling in a circle, slalom travel, test braking, drifting around a bend, traveling on snow or ice etc. as well as combinations thereof.

In a further refinement of the control device according to the invention, the plausibility checking stage uses, for checking the plausibility of a triggering decision, a parameter which is indicative of a change in the

activation state and a parameter which is indicative of a change in the operating state of a dynamic translational movement control system which can be switched on and off by a system or manually by the driver. Since lower threshold values may apply to situations which are critical for safety when the dynamic translational movement control system is switched on than when the dynamic translational movement control system is switched off, a change in the operating state can bring about a triggering decision. Such a triggering decision, which is brought about by the change in the operating state, is undesired and is rejected by the plausibility checking stage.

For example, in the case of a skidding process as a travel behavior which is critical for safety both the operating state of a dynamic translational movement control system (dynamic translational movement control system on/off) and the activation state of the dynamic translational movement control system (intervention in the translational movement dynamics: yes/no) are sensed. A triggering decision is then rejected as implausible if the dynamic translational movement control system has not changed from the off operating state into the on operating state until just before the triggering decision.

One advantageous embodiment of the control device according to the invention for actuating a means for protecting vehicle occupants and/or road users will be described in more detail below with reference to the drawing:

This will be done specifically with reference to an actuation of a means for protecting vehicle occupants. This is to be understood as referring not only to the means for protecting vehicle occupants such as for example seat belt pretensioners, knee cushions, seat

components which can be adjusted in terms of position or hardness, and other supporting and damping elements which can be actuated but also the actuation process for closing a sun roof or the side windows or the adjustment of a seat into a position which is optimum in terms of a collision. Of course, a means for protecting road users such as for example an engine hood which can be adjusted in terms of its angle of inclination or a pedestrian impact damping element which can be extended can also be actuated in the same way and using the same control device.

The single figure shows a block diagram of a control device 1 according to the invention for actuating a means 2 for protecting vehicle occupants. The control device 1 comprises a decision stage 3 and a plausibility checking stage 4.

The decision stage 3 senses parameters 5, 6 and 7, in particular dynamic translational movement parameters, which originate, for example, from control devices and sensors such as an ABS controller, a wheel speed sensor, a yaw rate sensor or a sensor for sensing the surroundings. The decision stage 3 determines, by means of the sensed parameters 5, 6, 7, whether a travel behavior of the vehicle which is critical for safety is occurring and if appropriate outputs a triggering decision, corresponding to the travel behavior which is critical for safety, for the means 2 for protecting vehicle occupants. The triggering decision may be composed of a single signal for activating the means 2 for protecting vehicle occupants, or may additionally comprise the triggering time, the triggering characteristic, the triggering speed, the degree of triggering and the actuation period of the means 2 for protecting vehicle occupants.

The plausibility checking stage 4 comprises a first substage 8 for determining a desired travel behavior,

i.e. a travel behavior of the vehicle which is brought about by the driver in an intentional and controlled fashion, and a second substage 9 for evaluating the triggering decision.

The first substage 8 uses parameters 7, 10, 11 which are sensed in the vehicle, for example the steering angle, the wheel speeds, the displacement of the accelerator pedal and brake pedal, and the yaw rate and/or the time profile of these parameters, to determine the desired travel behavior. In particular, for the purpose of plausibility checking it is also possible to use parameters which are not taken into account by the decision stage 3. The desired travel behavior which is determined is transmitted to the second substage 9.

The second substage 9 senses the desired travel behavior which is determined by the first substage 8 and the travel behavior which is critical for safety and is transmitted by the decision stage 3, and compares whether the desired travel behavior corresponds, within predefinable limits, to the travel behavior which is critical for safety. If this is the case, the second substage 8 evaluates the triggering decision based on the travel behavior which is critical for safety as implausible and prevents the means for protecting vehicle occupants from being actuated on the basis of this triggering decision.

The first and second substages can also be configured as a single stage which uses the sensed parameters 7, 10, 11 and the triggering decision which is determined by the decision stage 3 and/or the travel behavior which is determined and is critical for safety.

If the triggering decision is classified by the plausibility checking stage 4 as plausible or if the plausibility which is determined is at least high

enough, this leads to the triggering decision being enabled and the means 2 for protecting vehicle occupants being actuated. The actuation can be carried out directly by the plausibility checking stage 4.

Alternatively, the plausibility checking stage 4 enables a direct actuation of the vehicle occupant protection means 2 by the control device 1, in particular by the decision stage 3 or a control stage which is provided for that purpose.